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NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

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Date of mailing (day/month/year) 21 June 2000 (21.06.00)	
International application No. PCT/AU99/01001	Applicant's or agent's file reference IHA:FP11654
International filing date (day/month/year) 12 November 1999 (12.11.99)	Priority date (day/month/year) 12 November 1998 (12.11.98)
Applicant CANNING, John	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:

31 May 2000 (31.05.00)

☐ in a notice effecting later election filed with the International Bureau on:2. The election ☒ was☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

<p>The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland</p> <p>Facsimile No.: (41-22) 740.14.35</p>	<p>Authorized officer Nestor Santesso</p> <p>Telephone No.: (41-22) 338.83.38</p>
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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference MHK:SY:FP11654	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International application No. PCT/AU99/01001	International filing date (day/month/year) 12 November 1999	Priority Date (day/month/year) 12 November 1998
International Patent Classification (IPC) or national classification and IPC Int. Cl. ⁷ G02B 6/43 H01S 3/0933		
Applicant The University of Sydney et al		

1.	This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2.	This REPORT consists of a total of 3 sheets, including this cover sheet. <input type="checkbox"/> This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT). These annexes consist of a total of sheet(s).
3.	This report contains indications relating to the following items: I <input checked="" type="checkbox"/> Basis of the report II <input type="checkbox"/> Priority III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability IV <input type="checkbox"/> Lack of unity of invention V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement VI <input type="checkbox"/> Certain documents cited VII <input type="checkbox"/> Certain defects in the international application VIII <input type="checkbox"/> Certain observations on the international application

Date of submission of the demand 31 May 2000	Date of completion of the report 26 July 2000
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer F.C.PEARSON Telephone No. (02) 6283 2195

I. Basis of the report

1. With regard to the **elements** of the international application:*
- ☒ the international application as originally filed.
- ☐ the description, pages , as originally filed,
 pages , filed with the demand,
 pages , received on with the letter of
- ☐ the claims, pages , as originally filed,
 pages , as amended (together with any statement) under Article 19,
 pages , filed with the demand,
 pages , received on with the letter of
- ☐ the drawings, pages , as originally filed,
 pages , filed with the demand,
 pages , received on with the letter of
- ☐ the sequence listing part of the description:
 pages , as originally filed
 pages , filed with the demand
 pages , received on with the letter of
2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language which is:
- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).
3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, was on the basis of the sequence listing:
- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished
4. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/fig.
5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**1. Statement**

Novelty (N)	Claims 1-8	YES
	Claims	NO
Inventive step (IS)	Claims 1-8	YES
	Claims	NO
Industrial applicability (IA)	Claims 1-8	YES
	Claims	NO

2. Citations and explanations (Rule 70.7)**Novelty (N) and Inventive Step (IS)**

The only independent claim is claim 1 which is directed to a laser system wherein an array of diodes pumps a plurality of lasing waveguides. Other claims add extra features to claim 1. This is not disclosed in the prior art (apart from EP 0893719, which however was published after the earliest priority date).

Consequently the claims are novel and inventive.

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- 1 -

DIODE ARRAY SIDE-PUMPING OF A LASER SYSTEM

Field of the Invention

The present invention relates to diode pumped laser systems.

5 Background of the Invention

Diode pumped solid-state crystal lasers are becoming increasingly popular due to their compact nature and high output power characteristics.

However, for optical signal processing
10 applications it is desirable to utilise pumped waveguides to produce a laser output rather than solid-state crystal lasers, which are more difficult to incorporate into e.g. optical integrated circuits.

Suitable waveguides include e.g. doped cores of
15 optical fibres or doped planar waveguide structures.

Such waveguides, i.e. those which are capable of producing a laser output upon pumping with a pump energy, presently require an efficient coupling of the pump energy light signal into e.g. the doped core of the optical fibre
20 via the fibre cladding.

To minimise coupling losses various coupling techniques have been suggested, however, it is a common feature that they do require additional components/ structures which need to be integrated into e.g. the
25 optical integrated circuit, thereby resulting in more complex and less compact designs.

Furthermore, typically individual sources of the pump energy light signals are required for each waveguide to be pumped, the sources being individually coupled to the
30 respective waveguides.

Summary of the Invention

In accordance with the present invention, there is provided a laser system comprising: at least one array of closely spaced diodes arranged to emit radiant pump
35 energy, and a plurality of waveguides spaced adjacent the array, each waveguide being arranged to lase upon exposure to the radiant pump energy emitted from the diodes.

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A single diode array is thus utilised as a single source for the pumping of multiple waveguides at one time, without a requirement for individual coupling means.

The waveguides may be arranged to lase at
5 different frequencies. This can e.g. be utilised for provision of multiplexed optical signals.

The system can further include a coupler for coupling laser outputs of individual waveguides to form a combined laser output.

10 The system may further comprise reflection means spaced closely adjacent the waveguides and the array for reflecting the radiant pump energy emitted from the array back onto the waveguides.

The plurality of waveguides can comprise a series
15 of optical fibres or of planar waveguides.

The waveguides may form a multi-mode interference device.

The waveguides can be formed as part of a multimode waveguide structure which can be interconnected
20 to a single mode waveguide.

Brief Description of the Drawings

Notwithstanding any other forms which may fall within the scope of the present invention, preferred forms of the invention will now be described, by way of example
25 only, with reference to the accompanying drawings in which:

Fig. 1 illustrated a first example embodiment of the present invention;

Fig. 2 illustrates a second example embodiment of the present invention;

30 Fig. 3 illustrates a third example embodiment;

Fig. 4 illustrates a fourth example embodiment;

Fig. 5 illustrates utilisation of the principle of the present invention in a multi-mode interference device; and

35 Fig. 6 illustrates a further embodiment of the present invention

Description of Preferred and Other Embodiments

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In Fig. 1, there is illustrated a first example embodiment 1 of the present invention. In this embodiment, a series or bundle waveguides in the form of distributed feedback (DFB) fibre lasers 2, which can include tuned
5 Bragg grating structures to provide for particular frequency characteristics, are pumped by a diode bar 3. In the example, 32 DFB lasers are assumed to be provided. Of course, alternative arrangements are possible for example, the fibres could be more spaced apart and form a single
10 layer on the diode bar. Obviously, many different slacking arrangements are possible. The diode bar 3 acts as a high intensity pump which causes the DFB lasers to lase. The fibres are attached together by a 32 to 1 splitter 6 so as to provide output 7 having multiple combined frequency
15 channels.

The principles of Fig. 1 can be extended to other waveguide systems. For example, in Fig. 2, there is illustrated a waveguide system wherein a diode bar 10 is placed upon a waveguide 11 on which a series of DFB lasers
20 12 are formed in the core. The diode bar 10 is utilised to pump the DFB lasers 12 to provide for outputs 13.

Other arrangements are possible as illustrated in Fig. 3 wherein a waveguide 20 is provided on a substrate 21 and a diode bar 22 is provided for pumping the waveguide
25 20. The diode bar 22 is inclined with respect to the substrate 21 so that pumping wavelength energy is reflected by the substrate 21 and in turn by a reflector 24 so as to provide for enhanced operational characteristics. The pumping causes the waveguide 20 to lase so as to produce
30 output 25.

In Fig. 4, there is illustrated an alternative arrangement where the diode bar 30 is placed at one end of the substrate 31 which includes a series of DFB waveguides 32 placed therein. The diode bar 30 is utilised to cause
35 the DFB lasers to lase 32 so as to produce output 33.

The arrangements of Fig. 1 - 4 provide for an inexpensive form of arrangement of diode pumping of

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multiple waveguides simultaneously. This has significant advantage when constructing laser devices or other large area pumping of active waveguides. An example of its application is in the field of multi-mode interference devices. These devices can be, as illustrated in Fig. 5, formed on a waveguide 40 and include a series of active waveguides 41 between two couplers 42, 43. The diode bar 44 can be placed over the active portions so as to provide for large area pumping of the active waveguide portions 41 and therefore provide for different output couplings from input 46 to output 47 in accordance with requirements.

Turning now to Fig. 6, there is illustrated a further embodiment where a large power coupling is required for high power applications. A diode bar 50 is utilised to pump a large area multi-mode waveguide 51 which in turn is tapered into a single mode waveguide 52 so as to provide for high output power 53 pump wavelength which in turn can be utilised to pump other devices.

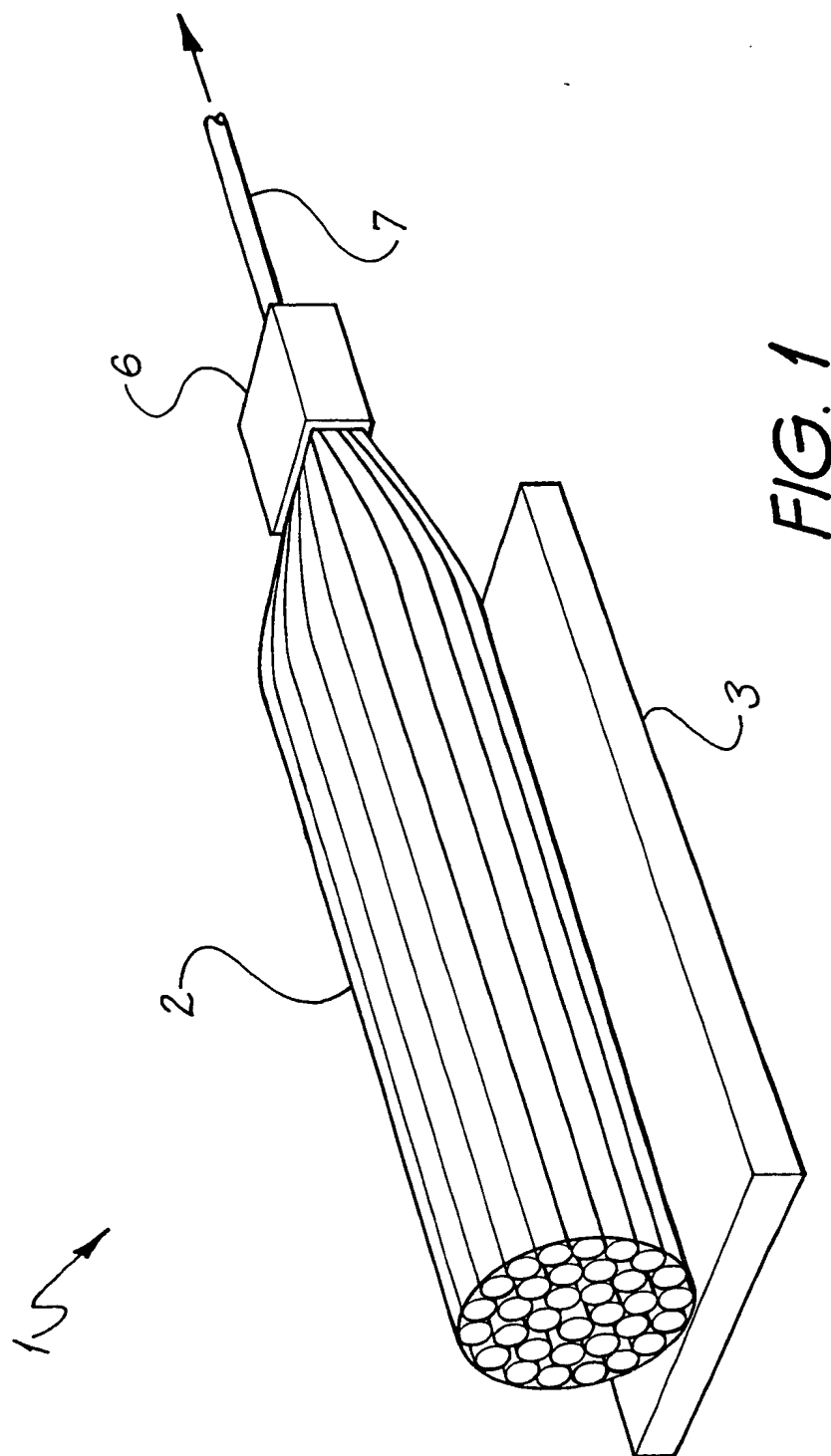
It would be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

In the claims that follow and in the summary of the invention, except where the context requires otherwise due to express language or necessary implication, the word "comprising" is used in the sense of "including", i.e. the features specified may be associated with further features in various embodiments of the invention.

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We Claim:

1. A laser system comprising:
 - at least one array of closely spaced diodes arranged to emit radiant pump energy; and
 - 5 - a plurality of waveguides spaced adjacent the array, each waveguide being arranged to lase upon exposure to the radiant pump energy emitted from the diodes.
2. A laser system as claimed in claim 1, wherein the waveguides are arranged to lase at different
- 10 frequencies.
3. A laser system as claimed in any one of the preceding claims, wherein the system further comprises a coupler for coupling laser outputs of individual ones of the waveguides to form a combined laser output.
- 15 4. A laser system as claimed in any one of the preceding claims, wherein the system further comprises reflection means spaced closely adjacent the waveguides and the array for reflecting the radiant pump energy emitted from the array back onto the waveguides.
- 20 5. A laser system as claimed in any one of the preceding claims, wherein the plurality of waveguides comprise a series of optical fibres.
6. A laser system as claimed in any one of the preceding claims, wherein the plurality of waveguides
- 25 comprises a series of planar waveguides.
7. A laser system as claimed in any one of the preceding claims, wherein the waveguides form a multi-mode interference device.
8. A laser system as claimed in any one of the
- 30 preceding claims, wherein the waveguides are be formed as part of a multimode waveguide structure which can be interconnected to a single mode waveguide.



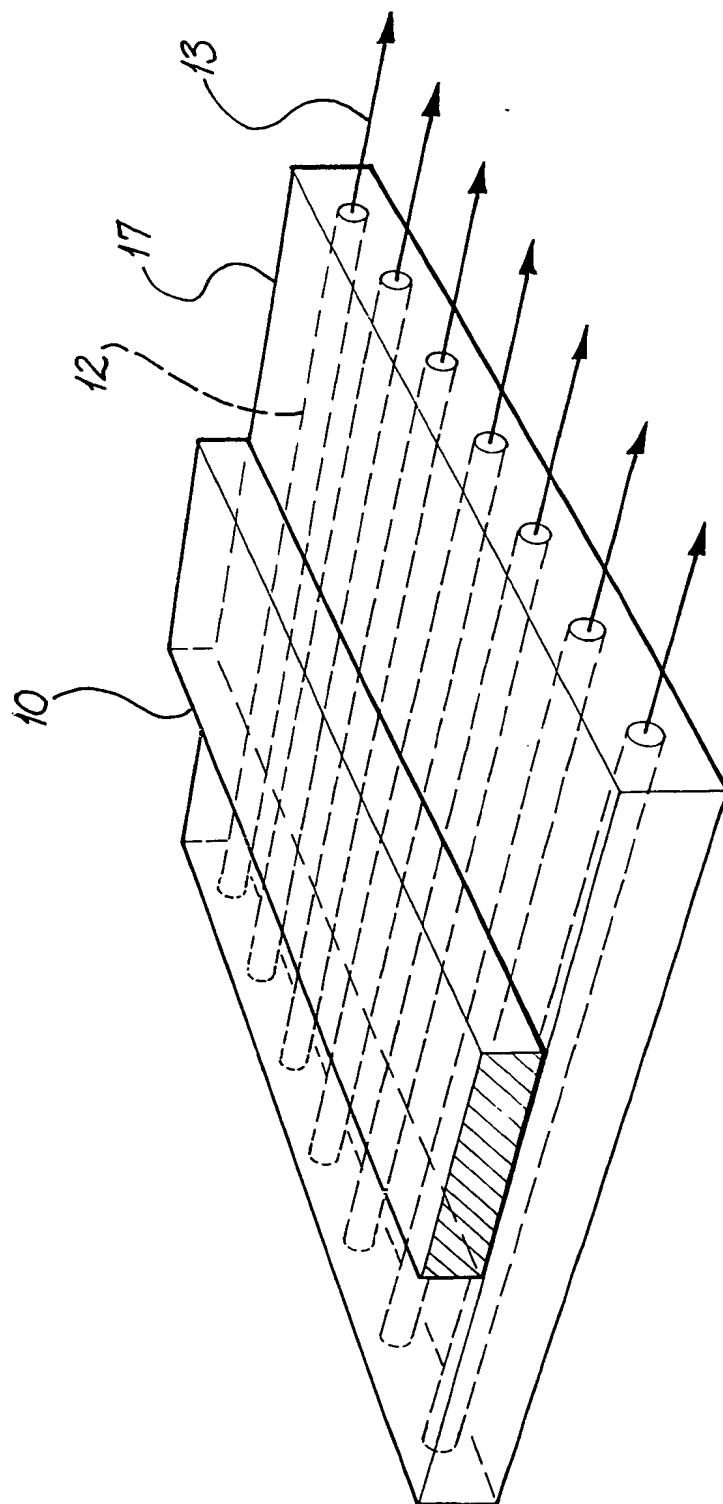
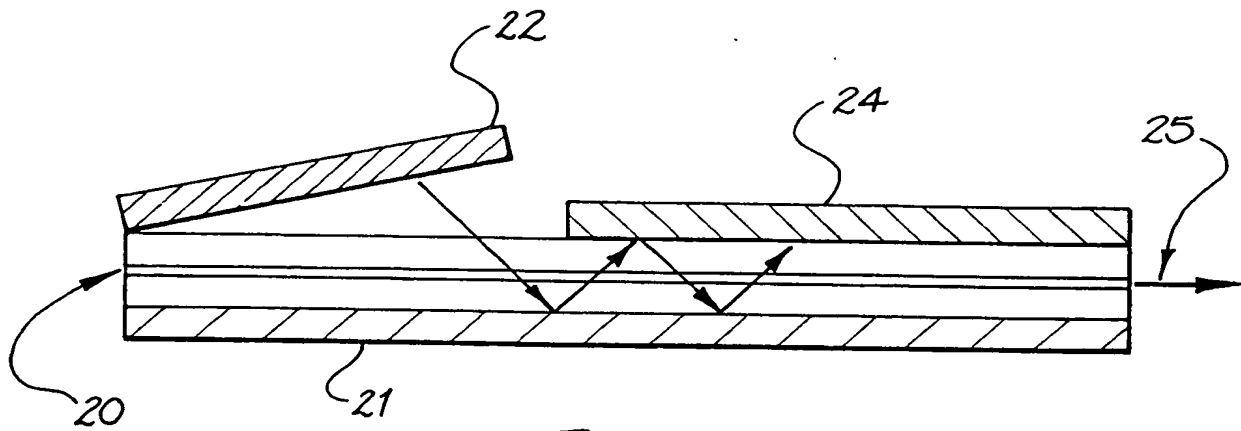
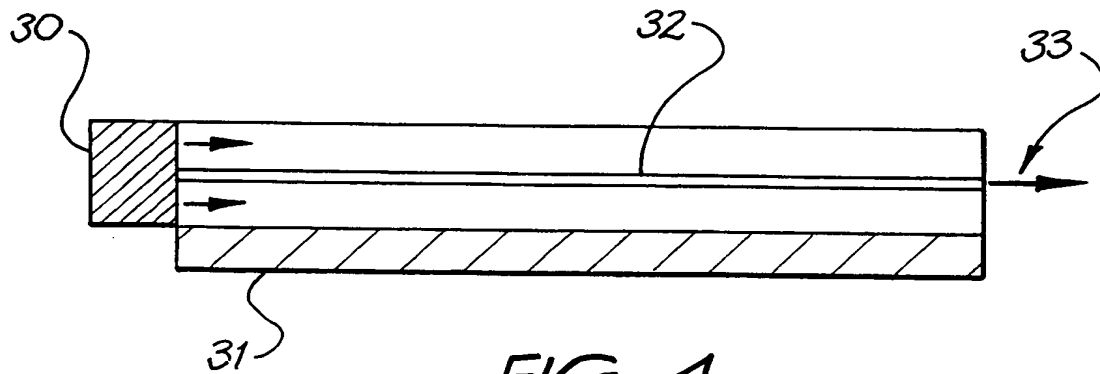


FIG. 2

*FIG. 3**FIG. 4*

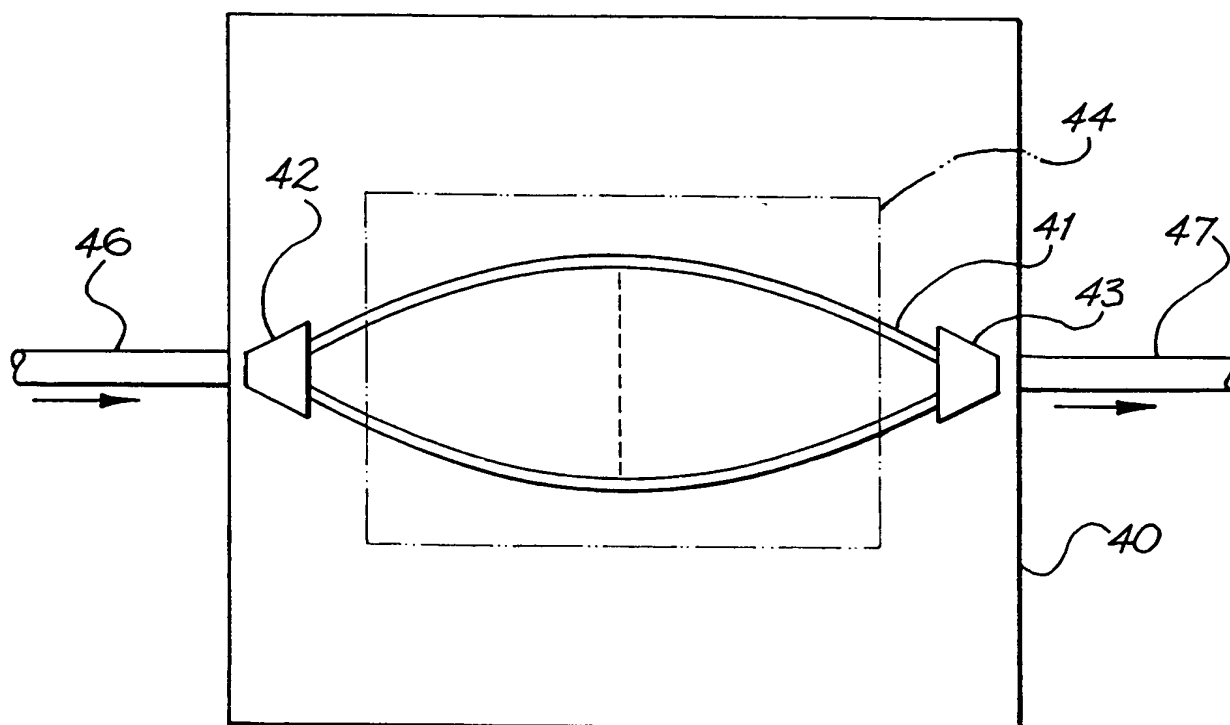


FIG. 5

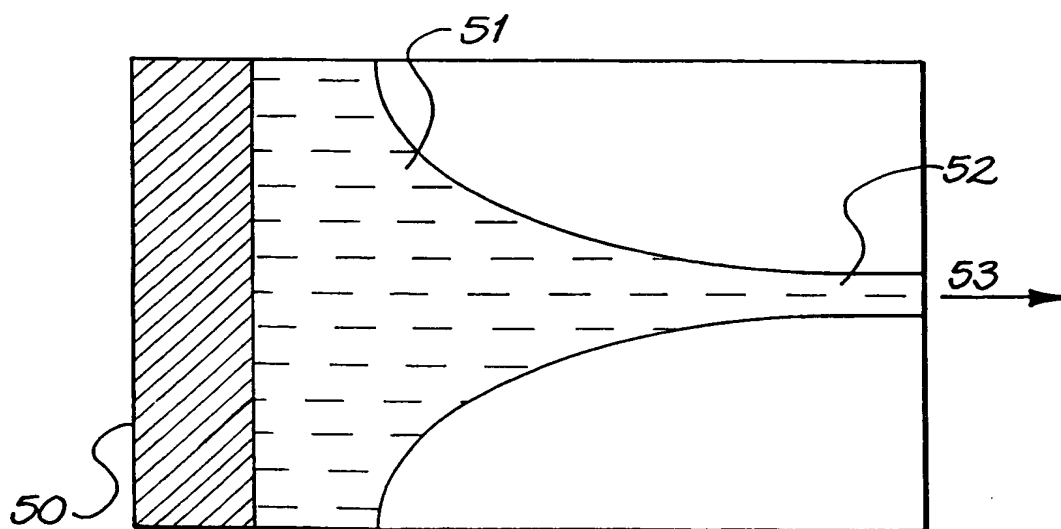


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU 99/01001

A. CLASSIFICATION OF SUBJECT MATTERInt Cl⁶: G02B 6/43 H01S 3/0933

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC G02B 6/42, 6/43, H01S 3/091, 3/0915, 3/0933

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: IPC AS ABOVE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPAT

Keywords

JAPIO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	EP,0893719,A (LUCENT TECHNOLOGIES INC) 27 January 1999. See whole document.	1-8
X	WO,96/38749,A (SPECTRA-PHYSICS,INC) 5 December 1996. See entire document.	1-8
X	US,5715270,A (ZEDIKER) 3 February 1998. See whole document.	1-8

☐ Further documents are listed in the continuation of Box C☒ See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

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later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X"

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y"

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"

document member of the same patent family

Date of the actual completion of the international search

10 January 2000

Date of mailing of the international search report

9 9 JAN 2000

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU 99/01001

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member			
EP	893719	JP	11074588	US	5887097		
WO	9638749	EP	774129	GB	2306051	US	5579422
		EP	486175	JP	5093828	US	5127068
		US	5436990				
US	5715270	AU	46461/97	WO	9813910		
END OF ANNEX							